PLATINUM ELECTROCHEMISTRY & CORROSION IN THE COURSE OF PULSING POLARIZATION

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INTRODUCTION

Platinum used as electrode material for medical and biomedical devices, such as an implantable (injectable) biomedical stimulator [1,2]. Progress in device development results in dramatically decreasing size of unit it all, and in their electrodes in particular. In this case current and charge density can excess safe limits, which can result in tissue damage and electrode corrosion.

The goal of our work was to evaluate corrosion performance electrodes of implantable biomedical stimulator and investigate their correlation with the electrochemical behavior of platinum.

EXPERIMENT

Corrosion and electrochemical experiments, equipment and samples described in [2, 3].

EIS measurements were provided on the Gamry FAS1 Femostat Potentiostat controlled by a personal computer with electrochemical analysis software.

Electrochemical tests were run in the temperature range from 25°C to 87 °C. Corrosion tests were at the temperatures of 37°C and 87 °C. All potentials are given versus Ag/AgCl reference electrode.

RESULTS AND DISCUSSION

Cyclic voltammetry measurements, in potential range starting from –650 mV to 1150 mV, show two peaks of hydrogen adsorption-desorption and one peak of oxygen reduction current during reverse potential scan. By integrating the cathodic peak area and value of hydrogen adsorption on platinum 220 μC/sq.cm at 25°C [4], roughness coefficient was estimated in the range of 1.9 to 2.6. Increasing of the temperature resulted in decreasing the hydrogen peaks and increasing of the peak, corresponding to the oxygen reduction.

EIS data as a Bode plot show that platinum exposed to electrolyte behaved similar as ideal capacitor, for which the slope of the Log Z vs. Log f plot is –1, and Φ value close to 90°.

Electrode pairs (stimulation-indifferent) were subjected to continuous capacitively coupled pulses stimulation polarization for a period of more than 6 months at the temperature 37 and 87°C. Current impulses maintenances cathodic charge density 65 μC/sq.cm for stimulation and 50 μC/sq.cm for indifferent electrodes and recharge anodic current 2.9 mA/sq.cm for stimulation and cathodic current 2.2 mA/sq.cm for indifferent electrodes.

Despite cathodic pulses polarization, average potentials of the stimulation electrodes were more positive, than on the indifferent. This potential difference was consistent with the potential shift during electrodes aging and influence of other experiment factors. Chronopotentiograms demonstrate a potential's shift during the impulses up to 1.5 V from average in cathodic and anodic directions for stimulation and indifferent electrodes respectively. Potentials delay on these curves correspondent platinum oxides and hydrogen adsorption and desorption recorded on the cyclic voltamogramms.

On the basis of the solution analysis, a corrosion rate of platinum was estimated in the range of 0.2 to 1.2 mg/sq.m*h.

A possible mechanism of platinum corrosion in our conditions is connected with the formation and reduction of platinum oxides and local acidification of the solution caused by the impulses of current.

REFERENCES

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